

WHAT IS CLAIMED IS:

1 1. A method for forming a consistency group of data, comprising:
2 providing information on a consistency group relationship indicating a plurality of
3 slave controllers and, for each indicated slave controller, a slave storage unit managed by
4 the slave controller;
5 transmitting a command to each slave controller in the consistency group
6 relationship to cause each slave controller to transmit data in the slave storage unit to a
7 remote storage in a manner that forms the consistency group; and
8 determining whether all the slave controllers successfully transmitted the data in
9 the slave storage units that is part of the consistency group to the remote storage.

1 2. The method of claim 1, wherein the remote storage is located at a remote
1 site and wherein each slave storage unit is stored within a storage system attached to one
2 slave controller.

1 3. The method of claim 1, wherein the operations of providing information
2 on the consistency group relationship, transmitting the commands to each slave
3 controller, and determining whether all the slave controller successfully transmitted the
4 data in the slave storage units to form the consistency group are performed by a master
5 controller in data communication with the slave controllers.

1 4. The method of claim 3, wherein the master controller also comprises one
2 slave controller managing one slave storage unit including data to transmit to the remote
3 storage.

1 5. The method of claim 1, wherein each slave controller maintains a first data
2 structure indicating updated data in the slave storage unit, wherein the slave controller
3 transmits data in the slave storage unit indicated in the first data structure to the remote
4 storage, further comprising:

5 transmitting a command to each slave controller to cause the slave controller to
6 generate a second data structure to indicate any writes received to the slave storage unit
7 during the transmittal of data in the slave storage unit indicated in the first data structure
8 to the remote storage.

1 6. The method of claim 1, further comprising:
2 transmitting a command to each slave controller to cause each slave controller to
3 initiate an operation to cause the data from the slave storage unit at the remote storage to
4 be copied to a remote backup storage after determining that all the slave controllers have
5 successfully transmitted the data in the slave storage units to the remote storage.

1 7. The method of claim 6, further comprising:
2 determining whether the data from the slave storage units at the remote storage
3 were successfully copied to the backup remote storage; and
4 transmitting a command to each slave controller whose slave storage unit data
5 was successfully copied to the remote backup storage to undo the copying of the slave
6 storage unit data from the remote storage to the remote backup storage in response to
7 determining that the data from the slave storage units at the remote storage were not
8 successfully copied to the remote backup storage.

1 8. The method of claim 6, wherein the copy operation from the remote
2 storage to the remote backup storage comprises a virtual copy operation.

1 9. The method of claim 1, wherein the remote storage comprises a plurality
2 of remote storage systems, wherein each remote storage system is coupled to one or more
3 remote storage controllers, wherein each slave controller transmits data to one or more
4 remote storage controllers to store the slave storage unit data in the remote storage
5 system coupled to the remote storage controller, and wherein each storage unit comprises
6 a volume of data.

1 10. The method of claim 1, further comprising:
2 copying data from local controllers to the slave controllers to store in the slave
3 storage units, wherein the local controllers and slave controllers are at different
4 geographical sites and the remote storage is at a remote geographical location with
5 respect to the geographical sites including the local and slave controllers.

1 11. A method for forming a consistency group, comprising:
2 receiving a command from a master controller to generate a first data structure to
3 indicate updates to a slave storage unit to form a consistency group initiated by the
4 master controller;
5 generating the first data structure;
6 transmitting complete to the master controller after generating the first data
7 structure;
8 copying updated data in the slave storage unit indicated in a second data structure
9 to the remote storage, wherein the data is copied to form the consistency group; and
10 transmitting complete to the master controller after successfully copying the data
11 in the slave storage unit to the remote storage.

1 12. The method of claim 11, further comprising:
2 indicating in the second data structure that data in the slave storage unit is not
3 updated in response to transmitting the corresponding data to the remote storage;
4 indicating in the second data structure updated data in the slave storage unit that
5 is indicated as updated in the first data structure in response to the second data structure
6 not indicating any updated data to copy to the remote storage; and
7 indicating updates to data in the slave storage unit in the second data structure
8 that are received after completing the copying of the data to the remote storage.

1 13. The method of claim 11, wherein the command received from the master
2 controller comprises a first command, further comprising:

3 receiving a second command from the master controller to cause the copying of
4 the slave storage unit data in the remote storage to a remote backup storage after
5 transmitting the complete indicating that the slave storage unit data was successfully
6 copied to the remote storage; and
7 transmitting a third command to a remote controller managing the remote storage
8 to cause the copying of the slave storage unit data in the remote storage to the remote
9 backup storage in response to receiving the third command.

1 14. The method of claim 11, further comprising:
2 queuing updates to the slave storage unit received while generating the first data
3 structure;
4 applying the updates to the slave storage unit after generating the first data
5 structure; and
6 indicating the queued updates applied to the slave storage unit in the first data
7 structure.

1 15. A system in communication with a plurality of slave controllers, wherein
2 each slave controller manages at least one slave storage unit, and wherein each slave
3 storage controller is in communication with one remote storage, comprising:
4 means for providing information on a consistency group relationship indicating a
5 plurality of the slave controllers and, for each indicated slave controller, at least one
6 slave storage unit managed by the slave controller;
7 means for transmitting a command to each slave controller in the consistency
8 group relationship to cause each slave controller to transmit data in the slave storage unit
9 to one remote storage in a manner that forms the consistency group; and
10 means for determining whether all the slave controllers successfully transmitted
11 the data in the slave storage units that is part of the consistency group to the remote
12 storage.

1 16. The system of claim 15, wherein the means for providing information on
2 the consistency group relationship, transmitting the commands to each slave controller,
3 and determining whether all the slave controller successfully transmitted the data in the
4 slave storage units to form the consistency group are performed by a master controller in
5 data communication with the slave controllers.

1 17. The system of claim 16, wherein the master controller also comprises one
2 slave controller managing one slave storage unit including data to transmit to the remote
3 storage.

1 18. The system of claim 15, wherein each slave controller maintains a first
2 data structure indicating updated data in the slave storage unit, wherein the slave
3 controller transmits data in the slave storage unit indicated in the first data structure to the
4 remote storage, further comprising:
5 means for transmitting a command to each slave controller to cause the slave
6 controller to generate a second data structure to indicate any writes received to the slave
7 storage unit during the transmittal of data in the slave storage unit indicated in the first
8 data structure to the remote storage.

1 19. The system of claim 15, further comprising:
2 means for transmitting a command to each slave controller to cause each slave
3 controller to initiate an operation to cause the data from the slave storage unit at the
4 remote storage to be copied to a remote backup storage after determining that all the
5 slave controllers have successfully transmitted the data in the slave storage units to the
6 remote storage.

1 20. The system of claim 19, further comprising:
2 means for determining whether the data from the slave storage units at the remote
3 storage were successfully copied to the backup remote storage; and

4 means for transmitting a command to each slave controller whose slave storage
5 unit data was successfully copied to the remote backup storage to undo the copying of the
6 slave storage unit data from the remote storage to the remote backup storage in response
7 to determining that the data from the slave storage units at the remote storage were not
8 successfully copied to the remote backup storage.

1 21. The system of claim 19, wherein the copy operation from the remote
2 storage to the remote backup storage comprises a virtual copy operation.

1 22. The method of claim 1, wherein the remote storage comprises a plurality
2 of remote storage systems, wherein each remote storage system is coupled to one or more
3 remote storage controllers, wherein each slave controller transmits data to one or more
4 remote storage controllers to store the slave storage unit data in the remote storage
5 system coupled to the remote storage controller, and wherein each storage unit comprises
6 a volume of data.

1 23. The system of claim 15, further comprising:
2 means for copying data from local controllers to the slave controllers to store in
3 the slave storage units, wherein the local controllers and slave controllers are at different
4 geographical sites and the remote storage is at a remote geographical location with
5 respect to the geographical sites including the local and slave controllers.

1 24. A system in communication with a master controller, comprising:
2 a slave storage unit;
3 means for receiving a command from the master controller to generate a first data
4 structure to indicate updates to the slave storage unit to form a consistency group
5 initiated by the master controller;
6 means for generating the first data structure;

7 means for transmitting complete to the master controller after generating the first
8 data structure;
9 a second data structure indicating updated data in the slave storage unit;
10 means for copying updated data in the slave storage unit indicated in the second
11 data structure to the remote storage, wherein the data is copied to form the consistency
12 group; and
13 transmitting complete to the master controller after successfully copying the data
14 in the slave storage unit to the remote storage.

1 25. The system of claim 24, further comprising:
2 means for indicating in the second data structure that data in the slave storage unit
3 is not updated in response to transmitting the corresponding data to the remote storage;
4 means for indicating in the second data structure updated data in the slave storage
5 unit that is indicated as updated in the first data structure in response to the second data
6 structure not indicating any updated data to copy to the remote storage; and
7 means for indicating updates to data in the slave storage unit in the second data
8 structure that are received after completing the copying of the data to the remote storage.

1 26. The system of claim 24, wherein the command received from the master
2 controller comprises a first command, and wherein the system is in communication with
3 a remote controller managing the remote storage, further comprising:
4 means for receiving a second command from the master controller to cause the
5 copying of the slave storage unit data in the remote storage to a remote backup storage
6 after transmitting the complete indicating that the slave storage unit data was successfully
7 copied to the remote storage; and
8 means for transmitting a third command to the remote controller managing the
9 remote storage to cause the copying of the slave storage unit data in the remote storage to
10 the remote backup storage in response to receiving the third command.

1 27. The system of claim 24, further comprising:
2 means for queuing updates to the slave storage unit received while generating the
3 first data structure;
4 means for applying the updates to the slave storage unit after generating the first
5 data structure; and
6 means for indicating the queued updates applied to the slave storage unit in the
7 first data structure.

1 28. An article of manufacture for forming a consistency group of data,
2 wherein a plurality of slave controllers manage slave storage units, wherein the article of
3 manufacture causes operations to be performed, the operations comprising:
4 providing information on a consistency group relationship indicating a plurality of
5 the slave controllers and, for each indicated slave controller, one slave storage unit
6 managed by the slave controller;
7 transmitting a command to each slave controller in the consistency group
8 relationship to cause each slave controller to transmit data in the slave storage unit to a
9 remote storage in a manner that forms the consistency group; and
10 determining whether all the slave controllers successfully transmitted the data in
11 the slave storage units that is part of the consistency group to the remote storage.

1 29. The article of manufacture of claim 28, wherein the remote storage is
1 located at a remote site and wherein each slave storage unit is stored within a storage
2 system attached to one slave controller.

1 30. The article of manufacture of claim 28, wherein the operations of
2 providing information on the consistency group relationship, transmitting the commands
3 to each slave controller, and determining whether all the slave controller successfully
4 transmitted the data in the slave storage units to form the consistency group are
5 performed by a master controller in data communication with the slave controllers.

1 31. The article of manufacture of claim 30, wherein the master controller also
2 comprises one slave controller managing one slave storage unit including data to transmit
3 to the remote storage.

1 32. The article of manufacture of claim 28, wherein each slave controller
2 maintains a first data structure indicating updated data in the slave storage unit, wherein
3 the slave controller transmits data in the slave storage unit indicated in the first data
4 structure to the remote storage, wherein the operations further comprise:
5 transmitting a command to each slave controller to cause the slave controller to
6 generate a second data structure to indicate any writes received to the slave storage unit
7 during the transmittal of data in the slave storage unit indicated in the first data structure
8 to the remote storage.

1 33. The article of manufacture of claim 28, wherein the operations further
2 comprise:
3 transmitting a command to each slave controller to cause each slave controller to
4 initiate an operation to cause the data from the slave storage unit at the remote storage to
5 be copied to a remote backup storage after determining that all the slave controllers have
6 successfully transmitted the data in the slave storage units to the remote storage.

1 34. The article of manufacture of claim 33, wherein the operations further
2 comprise:
3 determining whether the data from the slave storage units at the remote storage
4 were successfully copied to the backup remote storage; and
5 transmitting a command to each slave controller whose slave storage unit data
6 was successfully copied to the remote backup storage to undo the copying of the slave
7 storage unit data from the remote storage to the remote backup storage in response to
8 determining that the data from the slave storage units at the remote storage were not
9 successfully copied to the remote backup storage.

1 35. The article of manufacture of claim 33, wherein the copy operation from
2 the remote storage to the remote backup storage comprises a virtual copy operation.

1 36. The article of manufacture of claim 28; wherein the remote storage
2 comprises a plurality of remote storage systems, wherein each remote storage system is
3 coupled to one or more remote storage controllers, wherein each slave controller
4 transmits data to one or more remote storage controllers to store the slave storage unit
5 data in the remote storage system coupled to the remote storage controller, and wherein
6 each storage unit comprises a volume of data.

1 37. The article of manufacture of claim 28, wherein the operations further
2 comprise:
3 copying data from local controllers to the slave controllers to store in the slave
4 storage units, wherein the local controllers and slave controllers are at different
5 geographical sites and the remote storage is at a remote geographical location with
6 respect to the geographical sites including the local and slave controllers.

1 38. An article of manufacture for forming a consistency group of data,
2 wherein the article of manufacture receives communications from a master controller and
3 causes operations to be performed, the operations comprising
4 receiving a command from the master controller to generate a first data structure
5 to indicate updates to a slave storage unit to form a consistency group initiated by the
6 master controller;
7 generating the first data structure;
8 transmitting complete to the master controller after generating the first data
9 structure;
10 copying updated data in the slave storage unit indicated in a second data structure
11 to the remote storage, wherein the data is copied to form the consistency group; and

12 transmitting complete to the master controller after successfully copying the data
13 in the slave storage unit to the remote storage.

1 39. The article of manufacture of claim 38, wherein the operations further
2 comprise:
3 indicating in the second data structure that data in the slave storage unit is not
4 updated in response to transmitting the corresponding data to the remote storage;
5 indicating in the second data structure updated data in the slave storage unit that
6 is indicated as updated in the first data structure in response to the second data structure
7 not indicating any updated data to copy to the remote storage; and
8 indicating updates to data in the slave storage unit in the second data structure
9 that are received after completing the copying of the data to the remote storage.

1 40. The article of manufacture of claim 38, wherein the command received
2 from the master controller comprises a first command, wherein the operations further
3 comprise:
4 receiving a second command from the master controller to cause the copying of
5 the slave storage unit data in the remote storage to a remote backup storage after
6 transmitting the complete indicating that the slave storage unit data was successfully
7 copied to the remote storage; and
8 transmitting a third command to a remote controller managing the remote storage
9 to cause the copying of the slave storage unit data in the remote storage to the remote
10 backup storage in response to receiving the third command.

1 41. The article of manufacture of claim 38, wherein the operations further
2 comprise:
3 queuing updates to the slave storage unit received while generating the first data
4 structure;

- 5 applying the updates to the slave storage unit after generating the first data
- 6 structure; and
- 7 indicating the queued updates applied to the slave storage unit in the first data
- 8 structure: